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(54) **Composite shaft structure and manufacture.**

(57) The invention provides improvements to a composite member that has a plurality of plies. The improved composite member (10) has (1) an interior ply (12) which functions to dampen or resist sudden forces exerted on the composite member, (2) an intermediate load-carrying ply (14), and (3) an exterior abrasion-resistant ply (16). These plies have multiple, often intertwined fiber components disposed or imbedded with a matrix material, preferably Nylon-6 thermoplastic, to inhibit sharp edges during breakage. One or more of the plies typically has "bi-axial" or "tri-axially" braided fiber geometries wherein one or more fibers are helically wound about the circumference of the member. The helically oriented fibers are oriented at a selectively variable angle which influences the overall bending strength of the composite material. In one aspect, the angles of the fiber components and other factors are used to maintain substantially uniform cross-sectional area over the length of the tubular member while simultaneously varying the bending stiffness. In another aspect, the intermediate ply is constructed with two or more sub-ply. Such sub-ply can include tri-axially extending plies, and circumferentially-wound plies. The circumferentially-wound plies are often wound more tightly at the ends of the composite member to increase resistance to stresses caused by objects within the tubular shaft. A composite member constructed according to the invention resists sudden or impact forces and has high, selectively variable bending strength, high impact resistance, and safe failure modes.

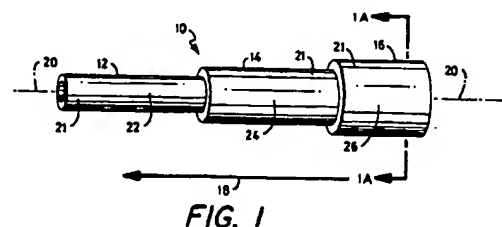


FIG. 1

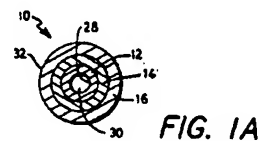


FIG. 1A

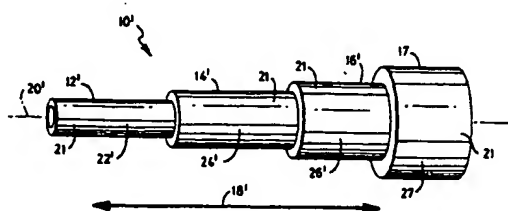


FIG. 1B

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# EUROPEAN SEARCH REPORT

Application Number  
EP 95 10 0159

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	US-A-3 080 893 (D. D. CRAYCRAFT)  * column 2, line 37 - column 3, line 9 * * column 3, line 36 - line 53; figure 1 * ---	1-5 7, 9, 13-17, 20-36	B29C70/24 B29C53/60 B29C53/68 B29D23/00
Y	EP-A-0 470 896 (P. H. VIELLARD)  * column 4, line 47 - column 5, line 4; figure 5 * * column 5, line 5 - line 44; figure 6 * * column 7, line 2 - line 10; figure 10 * ---	7, 9, 13-17, 20-36	
X	FR-A-2 219 289 (W. J. WHATLEY) * page 2, line 21 - page 3, line 10; figures 2, 5 * ---	1, 7, 13	
D, A	US-A-5 188 872 (P. A. QUIGLEY)  * column 5, line 60 - column 6, line 23; figure 1 * ---	1-6, 16-18, 24, 25, 27, 28, 30, 31	TECHNICAL FIELDS SEARCHED (Int.Cl.6)  B29C
A	EP-A-0 402 309 (GEBR. SULZER AG.) * column 3, line 16 - column 4, line 21; figures 1, 2, 6 * ---	1, 7, 10-19	
A	FR-A-2 501 579 (TECHNIQUE DU VERRE TISSE) * the whole document * ---	1-8, 10-18	
-/--			
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>11 September 1995</b>	Examiner <b>Fregosi, A</b>
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		I : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons A : member of the same patent family, corresponding document	

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Application Number  
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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP-A-0 127 553 (TECHNIQUE DU VERRE TISSE)  * figures 2-4 * * column 6, line 15 - column 7, line 27 * ---	1,6-8, 10-18, 20-34	
A	EP-A-0 204 607 (MANUF. D'APPAREILLAGE ELECTR. DE CAHORS) * column 2, line 27 - line 45 * * column 3, line 1 - line 4 * * column 4, line 12 - line 21; figures 1,2 * ---	9,35,36	
A	GB-A-1 305 198 (NATIONAL RESEARCH DEV. CORP.) * page 3, line 19 - line 32; figure 4 * -----	30-34	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>11 September 1995</b>	Examiner <b>Fregosi, A</b>
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons A : member of the same patent family, corresponding document</p>			

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